1907

# NOTE

ON

# CHROME TANNING

IN

# MADRAS

BY

ALFRED CHATTERTON.

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# CHROME TANNING.

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Hides and skins either in their raw condition or lightly tanned form important items in the export trade of India. Fluctuating from year to year and dependent to some extent upon the character of the season, they have for some years past averaged about 9 crores of rupees in value, but last year stimulated by the high prices obtainable in Europe and America the value of the trade rose to nearly 14 crores of rupees and in the list of Indian exports arranged in the order of their importance they have now reached the fourth place. The great bulk of the trade is done in the raw material and is mainly from the three Presidency ports of Calcutta, Bombay and Madras. The Calcutta trade is entirely in raw hides and skins, the Bombay trade includes a considerable percentage of tanned hides and skins, whilst in Madras only tanned hides are exported and in the skin trade nearly two-thirds of the value of the exports are in the tanned condition. Up to the year 1898 the export of raw material from Madras was non-existent, and although now in the skin trade it amounts to nearly 40 per cent. it has not grown so rapidly as was anticipated some four or five years ago.

The demand for leather throughout the world seems to be rapidly increasing and being in excess of the supply prices have had an upward tendency for many years past. Excluding the great stock raising countries such as the Australian Commonwealth and the Argentine Republic, India is one of the few countries which on account of its poverty is still able to export a very large proportion of the hides and skins which it produces. The external trade has risen to nearly 14 crores of rupees, but it is impossible to even roughly estimate the value of the internal consumption. Possibly its value is as great or

greater than that of the external trade and there is evidence that it is steadily rising. Indian skins are of good quality, but with few exceptions the hides are inferior and it is impossible to obtain a first-class manufactured product from them. Cawnpore is the centre of the modern leather trade and Bombay on a smaller scale produces leather in no way inferior. This industry has grown up under the stimulus of demands from the Military Department and its flourishing condition to-day is due not only to the expansion of military requirements but also to indents from other Government departments which in the aggregate require considerable supplies of leather goods. In recent years a considerable internal demand has grown up for cheap machine-made boots and shoes and it is probable that the Swadeshi movement, especially in Bengal, has benefited local manufacturers of such goods. Excluding boots and shoes the value of which is not given separately, the trade returns show that from 25 to 30 lakhs of rupees worth of leather or leather goods are imported into India yearly. The bulk of this trade is probably in dressed skins for book-binding and upholstery work, in high class leather for belting and machinery and to some extent in fancy leather goods. It is hardly probable that the whole of this not inconsiderable import business could be captured by native manufacturers, but there is absolutely no reason, except want of enterprise on the part of the manufacturers, why India should not produce dressed skins equal in quality to any made in Europe and America.

The bulk of the leather consumed in the country is very poor stuff and the methods of tanning are so crude that vast quantities of fairly good hides are converted into most inferior leather. The inefficiency of the indigenous tannery is notorious and in the aggregate the annual waste of material amounts to a sum which can only be estimated in crores

of rupees. Boots and shoes, sandals, harness, mussacks, paccali bags and bags for lifting water from wells for irrigation are among the chief articles for which the inferior country leather is in large demand. No information is available regarding this native business. The village chuckler was both tanner and leather worker, but in the South of India at any rate, the numerous tanneries which have sprung up for dealing with the surplus hides and skins available for the export trade, have also secured a good deal of his business as a tanner. Yet he is by no means extinct and the enormous increase in the export trade of the last two years indicates the probability that there is still a good deal of valuable material to be rescued from his primitive methods of treatment.

In one direction due to the increase in the number of wells used for irrigation from which the water is drawn by mhotes there has certainly been a considerable expansion in the local demand for leather. All over India the mhote or charsa is a familiar object and every year millions of good hides are converted into bad leather for these water lifting appliances. The material is not altogether suited for the work and in constant use water bags have but a comparatively short life. If anything could be done to improve the quality of the leather and render it more durable it would be conferring a very substantial boon upon the ryot and in proportion to the improvement there would be set free a corresponding number of hides for export. The increasing demand for leather in India is due to the improvement in the condition of the people and sooner or later it will affect the export trade unless in the meantime the available supplies of raw material are treated with greater respect and converted into better and more durable leather than at present. The main object of the present paper is to describe what is being done in Madras to bring about this very desirable result.

The mhote in good working order and with a water bag the capacity of which is properly proportioned to the weight of the bullocks is an extremely efficient method of lifting water when only animal power can be employed, but the normal condition of the ryot's mhote is far from satisfactory as the bag soon becomes brittle and tears and the rents are badly patched so that fully a third of the water which is lifted from the well falls back into it before the bag is emptied. In the matter of repairs the ryot is entirely in the hands of the village chuckler and if he can be supplied with a better material than the common country leather, there is but little doubt that as soon as he becomes practically acquainted with its advantages, he will readily adopt it even though it costs considerably more. In the South of India the piccotah with an iron bucket is almost universally employed in the Coast Districts where the water-bearing sands are not more than 12 or 15 feet from the surface and not a few mhotes, in use in brick wells, are of composite construction, sheet iron being used for the bag and leather only for the trunk. With care such mhotes are satisfactory, but they are easily damaged and difficult to repair. In many districts, the irrigation wells are large holes sunk into the rock and in practice it has been found that the leather bag is superior to the iron bucket, as the latter is so easily damaged against the rocky sides. Moreover, they must be very thin or else the weight becomes excessive and when very thin they require carefully looking after or they rapidly rust through. From time to time experiments have been made with various substitutes for leather, but nothing seems to have caught on and it remains therefore to improve the quality of the leather till a more satisfactory substitute for it can be found.

With these facts very forcibly impressed upon me whilst conducting a series of experiments on various types of water-lift in Southern India it was only

natural, when I learnt of chrome leather and the very slight action which water has upon it, to experiment with it and ascertain whether it was feasible or not to manufacture the leather in the country. The practical tanners of Madras whom I consulted in the matter were unanimously of opinion that owing to the climate chrome tanning would be a failure. They had made experiments themselves and their experiments led to nothing because their object in view was to produce a material suitable for export. That was not the way I looked at the matter at all and it seemed to me that though it might be impracticable to manufacture chrome leather or glacé kid which would find a market in Europe or America, yet it might be possible to produce in India chrome leather suited to Indian requirements. Accordingly the Government of Madras were addressed on the subject and a sum of Rs. 2,000 was placed at my disposal for experiments on the lines which I indicated, the main object being to produce a chrome tanned leather suitable for use in well irrigation. Neither I nor my assistant Mr. Brand, who was mainly in charge of the experiments during their initial stages, had any previous knowledge of leather manufacture and naturally we began working on a small scale, tried many experiments and met with not a few failures, but ultimately we were able to demonstrate the practicability of the original idea. That was probably the easiest part of the work as we were able to obtain much assistance from such books as Procter's "Principles of Leather Manufacture" and in working out the local Indian problem the Secretary of State for India permitted us to enlist the services of a first-class English expert.

The first stage has been successfully passed and we are now engaged in the more difficult matter of persuading the people of this country to give Indian

chrome leather a fair trial. We can manufacture chrome leather good enough for most purposes and the experience of the last two years has shown that the original anticipations of its superiority have been fully justified. The price list of our manufactures, which we have issued recently, contains a large number of favourable testimonials from people who have used it, but still the demand for chrome leather is small when compared with the enormous consumption of leather and only very slowly do sales increase. Nevertheless we are making progress and have now some sort of assurance that ultimately the chrome processes of manufacture will supersede the crude and wasteful methods of the chuckler.

Many hundreds of water buckets have been manufactured and brought into use in all parts of India and the general concensus of opinion of those who have used them is that the material is in every way superior to ordinary country leather and the life of a bucket very much longer. It is difficult to say what is the relative durability of the two kinds of leather on account of the variations in quality of the hides, but it may be safely assumed that chrome leather made from good hides is at least twice as durable as the best country tanned leather. As will be seen later on there is no great difference in the cost of manufacturing leather by the two processes, though naturally in an experimental tannery like that attached to the School of Arts in Madras where the work can only be carried on on a comparatively small scale, the cost of making chrome leather is much heavier than it would be in a large tannery doing a big trade. If we made bark tanned leather under similar conditions, the cost of doing so would be much greater than it is in an ordinary native tannery.

Having produced chrome leather suitable for water bags, or kavalais as they are locally known,

it was natural to experiment with the leather in other directions and boots and shoes, sandals, harness and a great variety of miscellaneous articles have been made from it. The natural colour of the leather is a pale lavender blue which is almost white when the leather is made in weak solutions. The colour is not at all displeasing and a good deal of it is worked up in the undyed condition, especially for harness in Madras. Usually, however, after the leather is tanned it has to be dyed which can readily be done and black leather and several shades of brown leather are regulary manufactured. Experiments also have been made in tanning skins and preparing glacé kid and though it must be confessed that our productions are not equal in finish to those imported, they have proved serviceable enough and being much cheaper have found a fairly ready sale. So far our work has been done on a small scale and almost entirely without the aid of machinery, but the Government of Madras have recently sanctioned the opening of a new tannery in the neighbourhood of Madras in which the manufacture of leather on a much larger scale will be possible. The plans for the new tannery have been prepared and include the installation of a fairly complete set of modern leather-dressing machinery. It will then be possible to do much better work and ultimately we hope to be able to materially displace the leather now imported from Europe and America.

*Characteristics of Chrome Leather.*—I do not propose to discuss these at any length, but it may be well to briefly draw attention to some of the more important points in which it differs from ordinary leather. In the first place, from a given weight of hide substance, the weight of chrome leather produced is considerably less than when it is converted into bark tanned leather. In the chrome process the hide substance is acted upon

by the chemicals in the tanning bath, but very little additional weight is gained by absorption, whereas, as is well known, a very marked increase in weight is obtained when the ordinary bark tanning processes are properly conducted From ten pounds of flint dry hide the average weight of bark tanned leather produced is nearly ten lbs., but the weight of chrome leather will be not more than $7\frac{1}{2}$ lbs. The ratio is roughly three-fourths. It therefore follows that buying chrome leather by the pound the price will always be at least 33 per cent. more than that of bark tanned leather. Chrome tanned leather is stronger than bark tanned leather, so much so that the loss in weight and decrease in sectional area is actually accompanied by an increase in the strength. Its chief physical characteristic is its extreme softness, which renders it very suitable for boot and shoe uppers. In many cases, however, stiffness is distinctly desirable, and such articles as solid leather bags and trunks are much better made of ordinary leather. Chrome tanned leather unless very carefully manufactured tends to stretch considerably more than bark tanned leather, and that for certain kinds of work has been counted a serious disadvantage especially when it has to be employed for military equipment. With care it is, however, possible to manufacture chrome leather which possesses no more stretch than ordinary leather and which at the same time has a considerably greater tensile strength. Harness made from the leather turned out in Madras has proved perfectly satisfactory, and large quantities of belting are in use where centrifugal pumps driven by oil-engines are lifting water for irrigation. This is very trying work for belting; and though we have not yet succeeded in producing an absolutely satisfactory chrome leather belt, yet those made in Madras are able to hold their own in price and durability when compared with the belts formerly used.

In the manufacture of sole leather the chrome process yields a material which is extremely durable, and it has been employed in making up thousands of pairs of boots and sandals. The leather is sufficiently soft to make it comfortable to the feet, and it possesses a power of resisting abrasion which has never been approached by the very best English sole leather. For boots and shoes it possesses one serious disadvantage due to the fact that, when wet, the surface becomes slippery and it is not altogether safe to walk about on chrome tanned soles in cities which are paved with asphalt or stone flags. This is a matter of no importance in India where pavements are almost non-existent, and the general suitability of chrome leather for both soles and uppers is attested by the popularity of Madras chrome leather boots among the planters of India. Thanks to the parcel post system, the planters of Assam and of remote stations in the Himalayas are able to get boots and shoes from Madras as easily and as cheaply as from Cawnpore or Calcutta.

The final property of chrome leather to which I wish to draw attention is its peculiar behaviour when wetted. Ordinary leather when wetted and dried becomes hard and stiff, and if soaked in water for any length of time, the water becomes turbid due to the solution of some of the constituents of the leather. On the other hand, chrome leather when wetted and dried remains quite soft, and prolonged immersion in water has no effect upon it. If ordinary leather be boiled, in a few minutes it is practically destroyed, whereas very little harm is done in the same time to chrome leather. Chrome leather is in no sense waterproof, but for practical purposes it is unaffected by water and is consequently *par excellence* the material best suited for exposure to the action of moisture. It is this property that led us to take it up in the first instance for water bags and it is that which renders it so

popular among people who live in damp climates. Ordinary leather to be kept in good condition must be treated with dressings of some kind or other from time to time and, although these preparations may be used for chrome leather, they are not needed to anything like the same extent and neglect to employ them does very little harm.

*Methods of chrome tanning employed in Madras.*—Three years ago under the orders of the Government of India a Monograph on Tanning and Working in Leather was specially prepared in each Province of India and those who are desirous of information regarding native methods of tanning will do well to consult these papers. They can be obtained from any of the Agents for the sale of Government publications, but so rapid has been the change during the last two or three years in the conditions under which the export trade is carried on that they are no longer reliable guides as to the commercial aspects of tanning.

In an addendum to the Madras Monograph a brief account of the earlier experiments in chrome tanning is given and in the remainder of this paper I propose to amplify that note and describe in some detail the actual methods of working employed in the Chrome Leather Department so that any one who wishes to start this industry or to carry on similar experiments may be able to obtain full information regarding our work in Madras.

*Hides and skins.*—The purchase of suitable raw material has proved to be one of the greatest difficulties we have had to contend with as not only at the outset were we inexperienced in regard to the methods of the trade, but we had little or no knowledge as to what was best suited for the chrome tanning process. There are a considerable number of tanneries in the neighbourhood of Madras, but they mainly deal with coast hides or Calcutta rejections and it is practically impossible to get suitable

hides from them. We soon found that satisfactory chrome leather could only be produced from good hides and latterly for light hides we rely almost entirely upon those which can be obtained from the Madras slaughter-houses. For a heavier class of hide, the best of which are good enough for harness leather we mainly rely upon the supply of Nellore cow hides of which hitherto we have been able to get as many as we wanted at very reasonable prices. For water bags, or kavalais as they are locally called, we found light cow hides unsatisfactory and expensive and, unless specially ordered otherwise, we invariably employ light buffs which are usually free from brands and are fairly cheap. There is a very considerable demand for chrome tanned sole leather which has to be made from hides much heavier than those usually obtainable in the local market and we have had some difficulty in getting a sufficient quantity. Buffalo hides are invariably used and in the wet salted condition they may weigh from 50 to 100 lbs. depending upon the exte... to the spread. One fairly large consignment of ... the from Rangoon proved extremely satisfact... which regard to price, but in the absence of machi... place for splitting the hides we found many of them ... and to be and they could only be worked up by ... e ordinary a heavy loss in shaving the leather do... suitable thickness. Latterly we have ... in water dry salted and arsenically cured hides in 24 hours cutta market and have found them fairly sat... r further The demand for our sole leather enables ... to remove make fairly large purchases at a time an... the hides, less difficulty as the business we can offer i... washed in worth the while of those in the trade ... olies. The Good calf skins we have found it almost ... ns of lactic to procure, but there has been no diffic... per cent. is matter of goat and sheep skins. ... solution the

It may here be convenient to ment... become very have a very considerable business in ta... her the last

of wild animals such as those of the tiger, panther, bear and various kinds of deer with the hair on and the results are extremely satisfactory if the skins reach us in good condition. The hair is unaffected by the chrome liquor and the skins when finished possess all the qualities of a good chrome leather. In a similar way we have tanned a good many crocodile hides and a large number of snake skins, the latter being in great demand for the manufacture of fancy articles, especially ladies' waist belts. In their natural colour they look very well and can be readily dyed to any required shade. Snake skins are very plentiful in India but so far as I know this is the first attempt that has ever been made to turn them to practical account. To obtain good results, the skins must not be damaged and special care has to be taken in killing the snakes.

*Processes preliminary to tanning.*—These differ very little from those ordinarily practised in native [illegible]ries but if good results are to be obtained, it [illegible]essary to exercise the greatest possible care at [illegible]age. The first step is to get the hides back [illegible] natural condition and free from blood and [illegible] dried hides require soaking in water for [illegible]ours and when quite soft should be washed [illegible] changes of water. The green and wet [illegible]es merely require to be thoroughly washed, [illegible] are then in a fit condition to be put in [illegible] pits. Owing to the fact that we are not [illegible] establish lime pits on the premises of [illegible] of Arts, this work has to be done [illegible] Madras Municipal limits in a native [illegible]d great difficulty has been experienced [illegible] native tanners to do the work properly. [illegible]e worked in a series of four, the first [illegible]ng the oldest lime and the last pit con[illegible] fresh lime. The hides pass through [illegible] of pits remaining in each pit about 2½

days, so that the whole liming process lasts about 10 days. The operations of unhairing, fleshing and scudding need not be described here in detail as there is nothing novel about them. It is most important that whilst the hides should be well plumped up or swollen by the action of the lime, this should not be continued long enough to allow of the lime dissolving any appreciable quantity of the hide substance. If this is not carefully attended to the final leather will certainly be unsatisfactory. In the manufacture of good sole leather this is of the greatest possible importance, and latterly we have considerably shortened liming process by the use of sulphide of sodium. The process adopted is as follows :—

About one pound of sodium sulphide is dissolved in as small a quantity of water as possible and to the solution from 6 to 8 lbs. of freshly slaked shell lime is added and the mixture thoroughly stirred More water is then added to bring it to the consistency of a thick cream. This mixture is allowed [illegible] stand for about 3 hours and is then spread ov[illegible] flesh side of the hides to be unhaired, afte[illegible] they are folded up and kept in a cool moist [illegible] about 24 hours, when the hair will be fo[illegible] sufficiently loosened to be removed in t[illegible] way.

After unhairing the hides are washed [illegible] and put into a tub of fresh lime where in [illegible] they are sufficiently plumped and ready f[illegible] treatment. After scudding it is necessary [illegible] as far as possible all traces of lime fro[illegible] and to this end, they are thoroughly [illegible] water and well trodded over by the c[illegible] last traces of lime are removed by me[illegible] acid of which a solution containing $\frac{3}{4}$ [illegible] employed. After being put in the [illegible] hides rapidly lose their plumpness and [illegible] slippery to the touch. To test whet[illegible]

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traces of lime are removed or not, a small piece is cut out of the thickest portion of the hide and to the cut surface a drop of the solution of phenol phthalein in alcohol is applied. If the cut surface turns red, it indicates that there is still some lime left, on the other hand if no colouration is produced it may be taken that the hide has been sufficiently delimed. Every hide is tested in this way and as soon as it passes the test is removed from the lactic acid bath and well washed in clean water.

*Pickling.*—The next operation through which the hides must pass is that of pickling which gives a preliminary alum tannage to the surface of the hides and thus prevents to a large extent the formation of a drawn grain when the hides are finally tanned. For the pickling solution 6 lbs. of potash alum and 4 lbs. of common salt per 100 lbs. of the drained weight of the delimed hides are dissolved in sufficient water contained in a large rotary drum. The hides are put into this solution and kept in it for about 24 ...rs, the drum being rotated from time to time by

...hough chrome tanning can be carried on in ...ubs, it is more convenient to employ large ... hold the tanning solution. They are made ...ak wood and are mounted on a suitable ...aming. The weight of the drum is carried ...ntrally placed brass rings one on each side ...st on friction rollers supported by iron ... attached to the framing. On one side of ... is fixed a large cast iron spur wheel of the ...eter as the drum and it is driven by a ... mounted on the framing. The drums ...nstructed in Madras range from 6 to 8 ...eter and from 3 feet to 4 feet 6 inches in ...present they are turned by hand, coolies ...ed for the purpose, but it is ultimately ...rive them all from a line of shafting. ...wer it is not possible to revolve them

more than two or three times a minute, but when driven by a belt from shafting, the gearing will be arranged so that the drums make from 4 to 8 revolutions a minute. For tanning the slower speeds are sufficient but for washing and deliming a more violent action is desirable and the higher speed is necessary. Inside the drums strong wooden pegs are fixed so as to turn the hides over as the drums rotate. This greatly quickens the process of tanning and the drums can also be usefully employed for washing, pickling and for removing the last traces of acid after the tanning processes are complete.

*Chrome tanning.*—There are two methods of chrome tanning known respectively as the single and the double bath process. The latter probably produces the finest leather, but the former is both cheaper and simpler to work and has been adopted in Madras exclusively as it yields sufficiently good results, and with the unskilled labour available there is much less risk of anything going wrong.

To secure uniform results and to save tanners, who are not chemists, from the risks of buying their own chemicals a number of tanning liquors have been put on the market ready for use. Experiments on a fairly extensive scale were made with two of these—one the well-known Tanolin which was supplied to us by the Martin Dennis Chrome Tannage Company of Newark, New Jersey and the other by Messrs. Lepetit, Dollfus and Gansser of Milan whose Chromo-Chrome produced excellent leather. With both the results were quite satisfactory, but the leather was no better than that made using the very simple process described by Professor Procter on page 212 of his Principles of Leather Manufacture. The tanning solution is made by dissolving 10 lbs. of chrome alum in 4 gallons of water. To effect the solution readily the alum should be crushed to a fine powder. Between 3 and 3½ lbs. of ordinary washing soda is dissolved in water and slowly added

to the solution of alum. Rapid effervescence takes place and the mixture should be thoroughly stirred. If too much soda is added, a heavy precipitate is formed and there is a waste of valuable chemicals. The chrome alum costs in Madras Rs. 14-8-0 per cwt. or roughly 2 annas a pound and one pound of chrome alum is sufficient for the production of 3 lbs. of finished leather. The carbonate of soda costs Rs. 7-8-0 per cwt., equivalent to slightly more than one anna a pound and as only one pound of washing soda is required for 10 lbs. of leather, it will be seen that the total cost of the chemicals employed in the tanning solution is very small and is actually less than that of the bark used in the ordinary processes of tanning. The tanning solution prepared in the above proportions contains 25 per cent. of chrome alum and is used as a stock solution. By diluting it with water solutions of any strength are readily prepared. Usually tanning commences in a one per cent. solution and ends in a solution the strength of which is about 5 per cent.

The tanning is done in the drums already described and usually about 500 or 600 lbs. of pelt are put in each drum. The drums are arranged in a series through which the hides pass, first entering the drum containing the weakest solution and finally passing out of that containing the strongest. To the tanning liquor in the first drum about 15 lbs. of sodium sulphate are added to prevent the formation of a drawn grain. The time occupied in completing the tanning processes depends upon the thickness of the hides. Sheep and goat skins are tanned in a few hours, cow hides in from one to three days, whilst the thick buffalo hides used as sole leather take from a week to ten days. The process could be quickened considerably if the drums were worked by night as well as by day and it would also be shortened if power were employed to drive the drums at a faster speed and continuously. The

hides are considered to be tanned sufficiently when the blue colour produced by the chrome liquor has penetrated right through the hide and there is no white streak in the centre. Experience seems to indicate that there is considerable danger of producing bad leather by over-tanning and that where the hides are of very unequal thickness in different parts they should be rounded off as much as possible before being put in the tanning drums. Leather which has been over-tanned soon becomes brittle and useless and it is impossible to emphasize too much the necessity for care at this stage.

As soon as it is decided that the tanning is complete the hides are removed from the solution and spread out one over the other on a wooden horse where they are allowed to soak and drain for 24 hours. The tanning liquor remaining in the hides contains a considerable percentage of sulphuric acid and it is absolutely essential that this should be completely removed or the leather will perish in a very short time. It may be here remarked that the three principal causes of the production of bad chrome leather are (1) over-liming, (2) over-tanning and (3) acid in the finished leather. It is not difficult to guard against damage arising from these causes once they are recognised, but there is no doubt that a good deal of chrome leather made both in Madras and elsewhere has been unsatisfactory through neglect to take proper precautions to prevent damage arising from the operation of any one or all of them. To remove the acid the hides are first washed in several changes of water and then drummed in a half per cent. solution of borax, the quantity of borax used being 3 lbs. per 100 lbs. of wet leather. Litmus paper is used to test whether or not the acid has been completely removed. When it is ascertained that the leather is free from acid it is taken out of the borax solution and well washed in several

changes of water to remove any soluble salts that may have formed in the substance of the leather.

*Fat-liquoring.*—For leather which is not to be dyed this is the final chemical process to which it is subjected, any further treatment being of a purely mechanical nature. The "Fat-liquor" is an emulsion of oil in a solution of soap and when the chrome leather is put into this the oil is absorbed and renders the leather soft and pliable. The soap employed is made in the following way:—

One hundred lbs. of castor-oil selected, because it is both cheap and gives satisfactory results, are placed in a wooden tub and 20 lbs. of caustic potash are dissolved in water and allowed to cool. When cold the caustic potash solution is slowly poured into the castor-oil, the mixture being constantly stirred and the stirring is continued for about quarter of an hour so as to ensure that the potash and oil are thoroughly mixed. After about 24 hours the soap is ready for use.

To prepare the fat liquor 7 lbs. of the soap are dissolved in two gallons of boiling water to which is added an equal quantity of castor-oil and the mixture is boiled. It is then placed in an emulsifier which consists of a cylinder made of tin plate about 3 feet 6 inches high and about 10 inches in diameter. In this works a loosely-fitting piston attached to a long handle. The piston is perforated with a large number of small holes and by working it up and down the cylinder after the mixture of oil and soap has been put in the emulsification is completed. When it is desired to produce the better qualities of leather 2 lbs. of egg yolk are added to the emulsion and thoroughly incorporated with it. When the emulsion is properly prepared it will mix with hot water without showing any trace of oil. For leather intended for water bags and rough usage it is desirable to make it absorb as much oil as possible

and in practice we find that about 10 per cent. will be taken up by the leather. This gives the surface a dirty appearance but that is a matter of no consequence.

The hides are fat-liquored in a drum which has been previously heated by means of boiling water. The door of the drum is closed and the requisite quantity of concentrated fat-liquor diluted with sufficient hot water at a temperature of 140°F. is passed in through the hollow axle of the drum which is then set in motion. After drumming for about half an hour it will be found that the fat-liquor has been entirely absorbed by the hides which are removed and laid over a horse to drain for several hours. Afterwards the hides are sleeked on stone tables and then stretched on wooden frames to dry. When the hides are dry they are taken off the frames and subjected to the staking process which gives the leather that softness which is one of its principal characteristics. This completes the process of converting both skins and hides into undyed chrome leather. When it is essential that the leather should have a good appearance the percentage of fat-liquor which the hides are allowed to absorb must be limited and when the staking operations are completed a little French chalk is dusted over the grain side. As we have no machinery for staking or shaving leather, the flesh side of the leather is necessarily rough and ragged and for any work in which a certain amount of finish is required the leather has to be shaved by hand.

*Sole leather.*—The process of unhairing now employed when the hides are destined for sole leather has already been described. The tanning takes from a week to ten days and the subsequent removal of the acid has to be carefully attended to on account of the greater thickness of the leather. It seems doubtful whether the process of fat-liquoring is necessary. At present the leather is drummed

in a concentrated solution of the fat-liquor the proportion employed being about 5 per cent. of the weight of the sammed leather. After fat-liquoring the leather is brought into a sammed condition either by allowing it to dry naturally or by passing it between a pair of rollers. When nearly dry it is ready for stuffing. The composition of the mixture employed is as follows :—50 lbs. of Burmese paraffin, $12\frac{1}{2}$ lbs. of tallow and $2\frac{1}{2}$ lbs. of resin. For the stuffing process it is advisable to use a flat copper or aluminium dish large enough to take the biggest of the butts which go through the process. The dish should be from 6 to 8 inches deep and supported on an iron frame. Underneath a fire is placed and the mixture of paraffin, tallow and resin melted. The sole leather butts in a sammed or partially dried condition are put into the melted mixture the temperature of which is sufficiently high to cause the air in the pores of the leather and the remaining moisture to rapidly pass off in bubbles. The stuffing penetrates thoroughly into the substance of the leather and when all the moisture has been driven off as is indicated by the cessation of the stream of bubbles rising from the surface of the leather it is removed from the dish and allowed to drain. As soon as it is cold the leather is rolled under considerable pressure between heavy rollers and is then ready for use.

*Dyed leather.*—Most of the leather required for boots and shoes, saddlery and similar articles has to be dyed either black or some shade of brown as the natural colour of the leather meets with but little appreciation. This adds considerably to the cost of the leather and from the beginning it was recognised that it would be desirable to devise a simple process which could be carried out without having resort to the comparatively expensive aniline dyes. Experiments in this direction have resulted in the production of a very satisfactory brown leather

prepared by subjecting the neutralised leather after it leaves the tanning solution to a superficial tannage with avaram bark (*Cassia auriculata*). The tanning liquor contains about 5 per cent. of bark and the hides are drummed in it for about half an hour. They are then removed and washed, and again drummed in a solution of Bichromate of Potash, there being about 8 oz. of the salt to every 100 lbs. of sammed leather. After this the leather is fat-liquored and finished in the usual way. The depth of colour can be increased by prolonging what is practically a bark tanning process till in the extreme limit a combination tannage is produced which will be dealt with later on. The brown leather thus produced was first intended only for the uppers of cheap ammunition boots. When worked up with the ordinary leather dressings it has proved quite satisfactory for all classes of goods though many people prefer a much darker colour.

Coloured leathers for boot uppers pass through exactly the same processes as those already described but it is permissible to allow of a somewhat longer liming so as to produce greater softness and flexibility. It is best to apply a mordant to the leather after the acid has been washed out of it and before the fat-liquoring process. The dyes employed are all aniline dyes and to fix them satisfactorily the leather must first be mordanted with some vegetable tanning material. In Madras we have found avaram bark both cheap and satisfactory. The leather after being neutralised is well struck out on the grain side and then transferred to a drum containing the decoction of bark of which about 5 per cent. on the weight of the sammed leather is employed. The temperature should be about 140°F. and the drumming should last for about half an hour. The leather which will then be of a light yellow colour is removed and washed in several changes of water after which it is spread out on the

sleeking table and thoroughly struck out on the flesh side so as to remove as far as possible all surplus mositure. The leather is now ready for fat-liquoring about 5 per cent. of which is used on the struck out weight of the leather. The fat-liquoring is done in a drum at a temperature of about 160°F. and when all the oil has been absorbed the hides are taken out and piled on a table where they are allowed to remain and gradually cool down. Each hide or skin is dipped in hot water and then well struck out on the grain side so as to remove all surface grease which if allowed to remain would make the subsequent dyeing uneven. With the enormous number of dyes now available any colour and almost any shade of that colour can easily be produced by using suitable combinations. So far we have not attempted to do anything more than turn out a good black dyed leather or brown leathers in light, medium and dark shades. For experiments in book-binding leathers a few coloured skins have been produced and a fair number of skins have been dyed scarlet to satisfy the taste of Mahomedans in the matter of chadas.

The dyes we employ are mainly of English manufacture being phosphine substitute, new acid green, azoflavine R and acid green. The proportion in which they are mixed depends upon the colour required and as typical mixtures the following are given:—

(1) 4 oz. of phosphine substitute and 1 oz. of new acid brown.

(2) 3 oz. of phosphine substitute, 3 oz. of new acid brown and $\frac{1}{4}$ oz. of acid green.

(3) 4 oz. of phosphine substitute and [illegible] oz. of new acid brown.

(4) 5 oz. of phosphine substitute, 2 oz. of new acid brown and $\frac{1}{3}$ oz. of acid green

These quantities are for a dozen average sized skins. The total quantity of dye stuff required varies with different classes of skins about half an ounce being required for a sheep skin and a little over an ounce for a light cow hide. The aniline dyes are dissolved in boiling water and the solution is filtered to remove any suspended impurities. The dyeing is done in drums at a temperature of about 150°F. About half the quantity of the dye stuff is used at the outset and the rest is added after about quarter of an hour. At the end of another 20 minutes three-fourths of the dyeing liquor is run out of the drum and egg yolk added to the extent of about 1 per cent. on the struck out weight of the leather after which the drumming is continued for another 20 minutes when the goods are removed, horsed up and struck out. The skins are stretched on boards or frames to dry and the grain side is lightly rubbed over with a mixture containing 20 per cent of glycerine in water. Before the skins are quite dry they are removed, being then in a good condition for staking which is entirely done by hand. After staking the colour may be improved by topping with a half per cent. solution of the dye used warm and applied with a soft brush. When this is done the goods should be again staked and then finally dried right out so as to be in a condition to receive a coat of seasoning.

*Seasoning.*—This is made by taking 3 oz. of white of egg and one pound of milk and making up with water to one gallon adding sufficient of the dye solution to tint the mixture. The seasoning is applied lightly on the grain side and when the goods are sufficiently dry they are glazed in a pendulum machine and afterwards re-staked and then the seasoning and glazing processes are gone through a second time, at the end of which the leather is ready for use.

*Blacks.*—Experiments with aniline dyes such as Corvoline B.T. using Cutch as a mordant have not been very successful and we have obtained better results with Haematine or logwood extract followed by the application of ferrous sulphate. About $1\frac{1}{2}$ per cent. of logwood extract calculated on the drained neutralised weight of the leather is dissolved in water to which is also added a quantity of washing soda equal in weight to about one-eighth of the weight of the logwood extract. The leather is first drummed in this solution and in about half an hour obtains a deep blue-black colour. The goods are then removed from the drum and sleeked well on the grain side and "pleated," i.e., the skin is laid on the table, doubled down the ridge with the flesh side inside and the shanks and belly are sleeked over so as to stick them together the idea being to keep the flesh side protected from contact with the iron solution through which the goods are now passed. This consists of a 1 per cent. solution of ferrous sulphate through which the skins are pulled twice and then immediately washed in hot water and struck out. The iron in the ferrous sulphate acts upon the small quantity of tannin present in the logwood extract and turns the blue-black shade into a thoroughly good black. It is necessary to carefully remove any excess of ferrous sulphate that the leather may contain or the process of fat-liquoring will be unsuccessful. This operation is identically the same as for brown leather and need not be described again. The seasoning for blacks should be of the following composition:—

Two oz. of logwood extract is dissolved in a quart of hot water and allowed to cool; $\frac{3}{4}$ oz. of ferrous sulphate in a quart of cold water. One pint of blood, 1 pint of milk and $\frac{1}{2}$ oz. of glycerine are diluted with one quart of water. To this the logwood extract solution is added and the whole well mixed.

Finally the ferrous sulphate solution is added and the whole made up to one gallon with water. The mixture is applied with a sponge and the goods glazed for the first time whilst very slightly damp. The staking, seasoning and glazing may with advantage be repeated after which the leather is ready for the market.

*Combination Tannage.*—For some purposes chrome leather is distinctly inferior to well tanned bark leather and it is possible by subjecting the hides to both processes to obtain a material which possesses in a marked degree the good qualities of both tannages. The production of such leathers will of course be much more expensive than when either process is used alone and till quite recently it has been considered outside our sphere of work to attempt to produce the more expensive kinds of leather. In certain directions, however, we have met with a distinct demand for a locally produced leather of high quality and this we have endeavoured to meet by supplying combination tannages.

There are three ways of carrying out a combination tannage. Either process may be carried out first, or the two tanning liquors may be mixed together and allowed to act simultaneously. Most excellent leather has been produced by purchasing from local tanners hides and skins which have been lightly tanned in avaram bark but not subjected to any process of dyeing with myrabolams or stuffing with grease. These lightly tanned kips or skins were chrome tanned in the usual way and either finished in their natural colour or dyed brown or black. The resulting leather has proved very suitable for many purposes and as the natural colour is a not unpleasing brown it does not really cost anything more than ordinary chrome leather dyed brown. In a similar way sole leather has been made from combination tanned hides, but there has not yet been time to ascertain whether there is any

very marked advantage in the process. For highly finished boots it can certainly be employed as it lends itself more readily to a neat finish than does ordinary chrome sole leather. So far it has been mainly with a view to producing good harness leather that we have experimented with combination tannages and we have arrived at the definite result that there seems to be a limit to the amount of stretch in combination tanned leather and stirrup leathers made from it have proved quite satisfactory and have shown no stretch whatever after being made up. Harness similarly has proved extremely satisfactory and being unaffected by moisture has proved in every way suited for damp climates and wet weather. The combination tannage produces an excellent leather for boot uppers having rather more body in it than ordinary chrome leather whilst at the same time it is equally soft and unaffected by water.

Experiments have also been made in which the hides are first subjected to the chrome process and then tanned in an avaram bark solution. As already mentioned this process has been largely employed more with a view to dyeing leather than to materially altering its properties and so far it has proved perfectly satisfactory. Experiments with a more prolonged vegetable bark tannage have not been satisfactory and at present it seems doubtful if this order of tanning will be able to compete with that in which the vegetable process takes precedence. Tanning with mixed solutions has not yet been tried.

*Cost of Chrome Tanning.*—In native Tanneries in the Madras Presidency the rate usually charged for tanning hides varies from 2 to $2\frac{1}{2}$ annas per lb. on the weight of leather produced. Chrome tanning costs us slightly over 3 annas per lb., so that if allowance be made for the smaller weight of chrome leather produced from a given weight of hides, the actual cost of tanning a hide by the chrome process

is no greater than by the bark process. Dyed leathers however cost considerably more, but then they are only used for superior work, and it would be unfair to compare them with the normal productions of a country tannery. It is important to remember that the chrome process of tanning is a much shorter one and that consequently much less capital is locked up in the tannery. The saving of capital which is thus effected is more than sufficient to provide for the extra expense in plant and machinery which a well equipped chrome tannery involves when compared with the ordinary bark tannery.

*Conclusion.*—The processes of chrome tanning which we follow in Madras have been described in the above general terms not because there is any novelty about them but because there is in India an idea more or less prevalent that chrome tanning involves the introduction of machinery on a large scale and methods of operating better adapted for employment among more advanced communities. Whilst the trade in hides and skins is in a flourishing condition the art of tanning in India except in a few tanneries is in a deplorably backward state. In the Madras Presidency where the tanned skin trade represents the highest development of native tanning nearly all the best skins are bought up and exported to Europe or America in a raw state. Last year the average value of each raw skin exported was nearly Rs. 1–12–0, whilst the average value of tanned skins was only Rs. 1–3–0. The report of the Committee of the Society of Arts on leather for book-binding condemned East-India skins tanned with avaram bark as being the worst and most unfit from which to manufacture book-binding leathers. This was not due to any defect in the skins themselves but solely because avaram bark contains catechol tannin and experiments have clearly demonstrated that to secure the necessary durability in leather bindings those only which have been

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prepared with a pyrogallol tannin can be used. The effect of this report has been to restrict the market for Madras tanned sheep and goat skins and to encourage the export of all the best skins in the raw state. Myrabolams and divi-divi both yield excellent pyrogallol tannins. The former are already exported on a large scale and it would probably be wise to ascertain whether these natural products of the soil could not be utilised, not so much to bolster up a moribund industry as by a re-arrangement of ideas, to create a new one. The hides and skins of the domestic animals of India have come to be an important asset and it seems desirable that the most, that can be made, should be made of this national source of wealth. The abolition of the crude system of branding cattle which now prevails would probably add fully a crore of rupees to the value of the exports of hides and the abolition of the village-tanner would even lead to greater results. It will probably be a long time before the people can be induced to abandon branding, but the gradual extension of the chrome process and the keener demand for raw hides which the enhanced value of leather now enables dealers to offer will do much to improve the methods of realising the real value of hides and skins.

ALFRED CHATTERTON.

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